Radio Shack
TRS-80
POCKET COMPUTER

TRS-80®

PC-4 OWNER'S MANUAL

CATALOG NO. 26-3650A

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Thank you very much for purchasing the PC-4. This handy, personal computer is excellent for those who are beginning to learn about computers.
With the PC-4, you can enter the world of computers and start programming using BASIC language.

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This manual explains fundamental computer operation and gives you an outline of BASIC language.
Before using the computer, read this manual thoroughly and master each function fully. Be sure to observe the Use Precautions to ensure the longevity of the instrument.

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Prior to Operation

This computer is delivered to you through our strict testing process, high-level electronics technology and rigid quality control.
In order to ensure the longevity of the computer, please be sure to note the following precautions.

■ Use Precautions

- Since the computer is constructed using precision electronics parts, never attempt to take it apart. Also, do not subject the computer to shock such as throwing or dropping it and avoid extreme temperature variations. Be especially careful to avoid high temperature locations where there is also high humidity or a lot of dust. However, if the ambient temperature is too low, the display response speed may be slow or there may be no display. When normal temperature conditions are resumed, the computer will operate normally.

- Do not attempt to connect any equipment to the adapter socket other than our exclusive optional equipment.

- While the computer is operating, a "—" (dash) will be displayed. At this time, key operation will be ineffective except for one section. Therefore, always be sure to press the keys while confirming the display.

- Be sure to replace the batteries every 2 years regardless of the amount of use.
  Worn out batteries may leak and cause a malfunction. Therefore, never leave old batteries inside the computer.

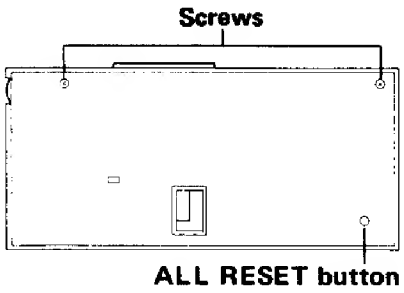
- To keep the computer clean, wipe off surface with a soft, dry cloth or one which has been dampened with a neutral detergent.

- In case of malfunction, contact the Radio Shack store where it was purchased.

- Prior to seeking service, please read this manual again and check the power supply as well as the program. Also, an operational error may be the cause of an apparent malfunction.

■ Power Supply and Battery Replacement

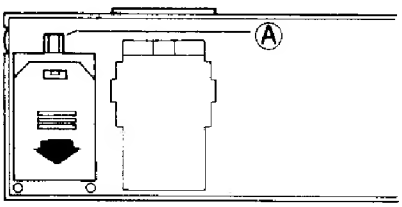
This instrument uses two lithium batteries (CR2032 Cat. No. 23-162) for a power supply. If the display contrast is weak even when the contrast control is adjusted for maximum, (refer to page 11), the batteries should be replaced at the earliest opportunity. Be sure to replace the batteries every 2 years.



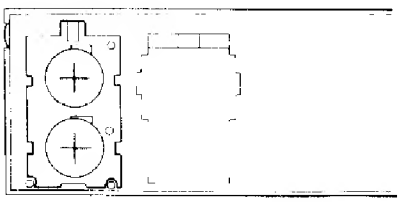
• How to Replace the Batteries

(1) After turning the power switch off, loosen the two screws on the back and then remove the rear panel.

(2) While pressing on Ⓐ, slide the battery compartment lid in the direction of the arrow and remove it.



(3) Remove the old batteries.
(This will be easier if you tap the unit lightly with the battery compartment facing down.)



(4) Using a dry cloth, wipe off the new batteries and insert them with the ⊕ (positive) side facing up.

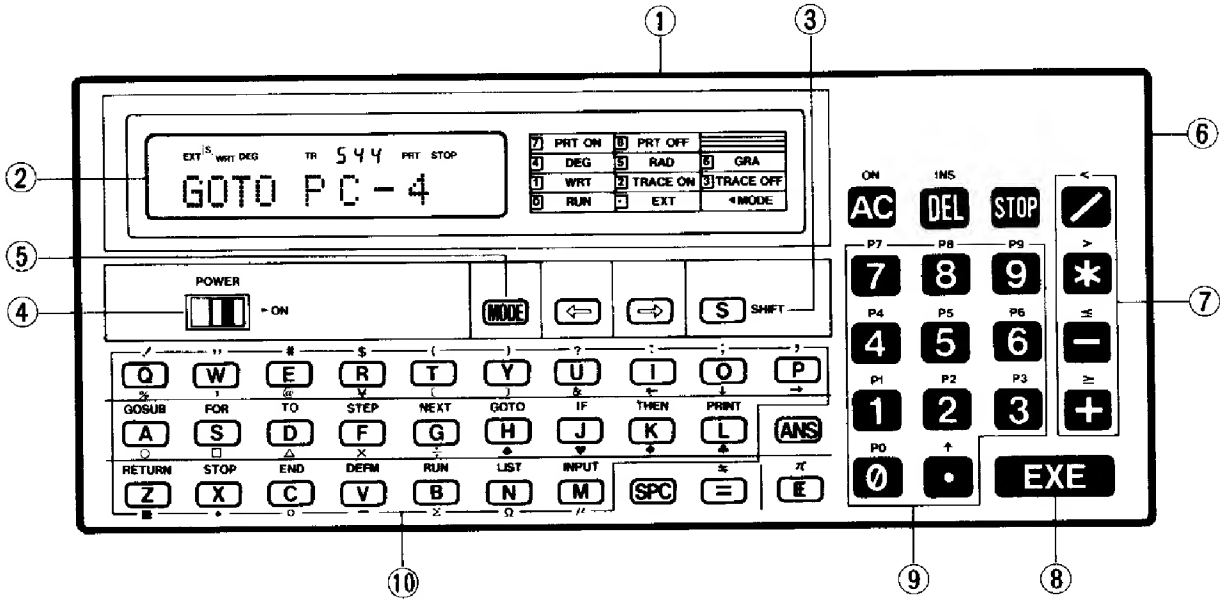
(5) Slide the battery compartment lid closed while pressing down on the batteries.

(6) Replace the rear panel and tighten the screws. After turning the power switch on, press the ALL RESET button with a pointed object.

* Be sure to replace both batteries.
* Never throw the old batteries into a fire. This is very dangerous as they might explode.
* Be sure to position the ⊕ (positive) and ⊖ (negative) terminals correctly.

Chapter 1

Name and Operation of Each Section



① Adapter connector
② Display window
③ Shift key
④ Power switch
⑤ Mode key
⑥ Display contrast control
⑦ Calculation instruction keys
⑧ Execute key
⑨ Numerical keys and decimal point key
⑩ Alphabet keys

1-1 Name of Each Section

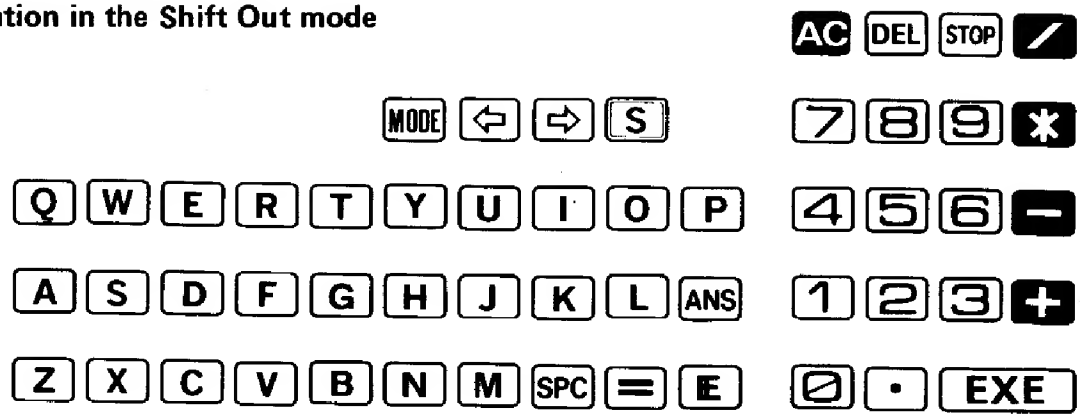
Each key has 1 or 2 operations. The operations can be divided by using the Shift Out mode, whereby the keys are pressed directly, and the Shift In mode, whereby keys are pressed after pressing the [SHIFT] (SHIFT) Key.

Example:

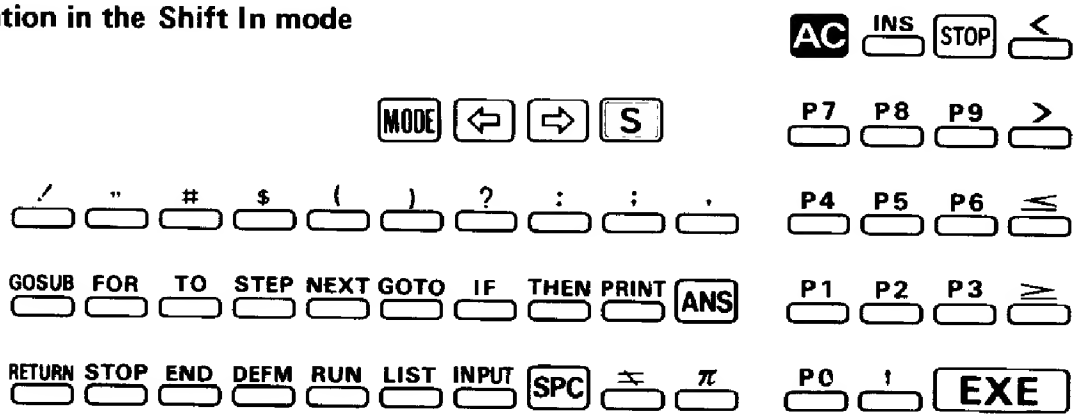
GOSUB —— Shift In mode

[A] —— Shift Out mode

Key operation in the Shift Out mode



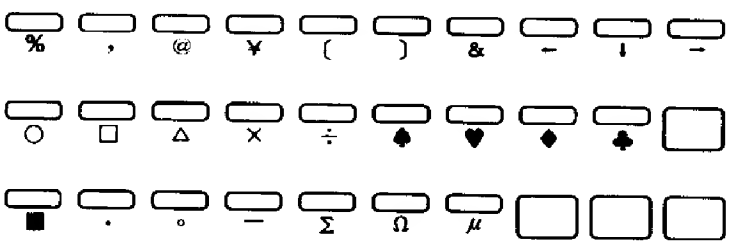
Key operation in the Shift In mode



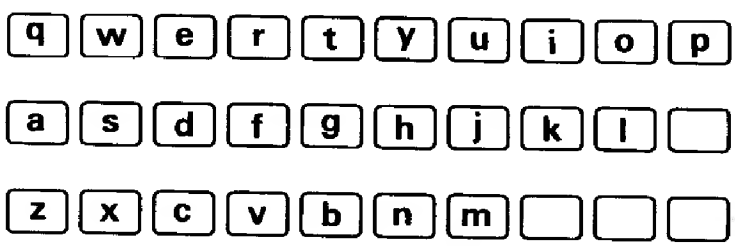
* In the Shift In mode, the alphabet keys become one-key commands and the numerical keys become program area designation keys.

- In addition, using the Extension Mode (press MODE • and "EXT" shows on display), while in the Shift In mode results in special symbols displayed for each alphabet key that is pressed. Lower case letters will be displayed, however, if the Extension mode is used while in the Shift Out mode.

Shift In mode using the extension mode



Shift Out mode using the extension mode



[S] SHIFT Shift Key (Symbolized by [SHIFT] hereafter)

If this key is pressed, the Shift In mode is selected ("[S]" is displayed) and the Shift In functions on the keyboard can be used. Do not confuse [S] (red key) with the regular [S] (letter "S").

[MODE] Mode Key

This is pressed in conjunction with [·] and [0] through [8] Keys to designate the computer's condition or angular unit in advance.

[MODE][·] ..... "EXT" is displayed. The Extension mode is designated and lower case letters or special symbols can be used, depending on whether the Shift In or Shift Out modes have been previously selected. To release the Extension mode press [MODE][·] again.

[MODE][0] ..... "RUN" is displayed. Manual calculation and program execution can be performed.

[MODE][1] ..... "WRT" is displayed. Program write-in and checking/editing can be performed.

[MODE][2] ..... "TR" is displayed. Execution trace can be performed. (See page 43 for details.)

[MODE][3] ..... "TR" disappears from display. This mode disables the execution trace function([MODE][2]).

[MODE][4] ..... "DEG" is displayed. The angular unit will be designated as "degree".

[MODE][5] ..... "RAD" is displayed. The angular unit will be designated as "radian".

[MODE][6] ..... "GRA" is displayed. The angular unit will be designated as "gradient".

[MODE][7] ..... "PRT" is displayed. If a printer is connected, printout can be performed.

[MODE][8] ..... "PRT" disappears from display. This mode disables the printout function ([MODE][7]).

[⇦][⇨] Cursor Keys

Press to move the cursor left or right. If pressed once, cursor moves one character space. If kept pressed the cursor continues to move automatically.

ON [AC] All Clear/ON Key

- Press to clear the entire display.
- If pressed during program execution, program execution will stop.
- When an error message is displayed, press to clear the error message display.
- When auto power off is in operation (automatic energy saving function, refer to page 13), and the display is off, press to turn power back on.

INS [DEL] Delete/Insert Key

- Deletes one character at the position of the blinking cursor.
- In the Shift In mode, press to open up one character space for character insertion.

[STOP] Stop Key

If pressed during program execution, "STOP" will be displayed and program execution will stop at the end of the line.
During execution trace with "STOP" on the display, this key displays the program area number and the line numbers.

[EXE] Execute Key

- Press [EXE] instead of "=" when the result of a manual calculation is required.
- In the "WRT" mode, when writing in a program, press to write (store) each line in the computer. If this key is not pressed, nothing will be written in.
- In the "RUN" mode, press for data input during program execution or to continue program execution while "STOP" is displayed.

[ANS] Answer Key

In manual calculations, press [ANS] (answer) to recall the previous calculation result.

[π] [E] Exponent/Pi Key

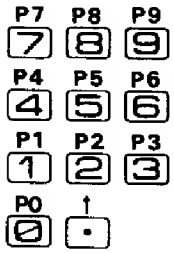
When inputting exponential values, press [E] after inputting the mantissa portion.

Example: 2.56×10^{34} → [2][.][5][6][E][3][4]

* The exponential portion may be a maximum of ±99. If this is exceeded, an error will occur.

[≠] [=] Equal Key/Comparison Key

- Press [=] when using a substitution statement or for comparison when using an IF statement.
- In the Shift In mode, press [=] for comparison when using an IF statement.

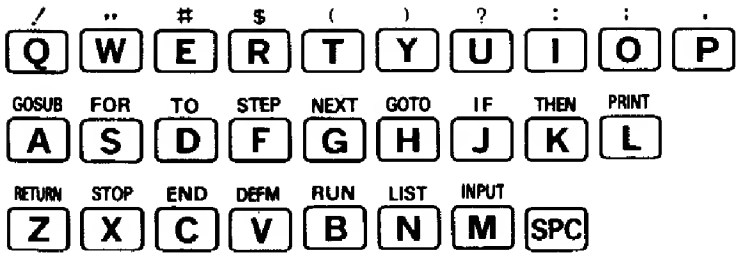


Numerical Keys/Program Number Keys

- Press when inputting numerical values into the computer. Press [.] at the location of the decimal point.
- In the Shift In mode, [P0] through [P9] become the program number designation keys and when a program has been written in, the program will start.
- The [↑] Key is pressed in the Shift In mode when a power (x^y) is required.

[≥] [≤] [>] [<] [+] [−] [×] [÷] Calculation Instruction Keys/Comparison Keys

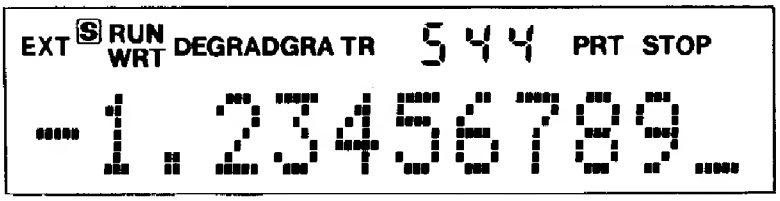
- When performing addition, subtraction, multiplication and division, press the respective keys.
  [×] is used for multiplication (corresponds to "x").
  [÷] is used for division (corresponds to ÷).
- In the Shift In mode use these keys for comparison of a judgment in an IF statement.



Alphabet Keys/One-Key Command Keys/Character Keys

- When writing in a program in the Shift Out mode alphabetical characters are displayed. Press the SPC Key when a space is required.
- Q ~ P Keys: In the Shift In mode the characters written on the panel above the keys are displayed.
- A ~ M Keys: In the Shift In mode the one-key commands which are written on the panel above the keys are displayed.

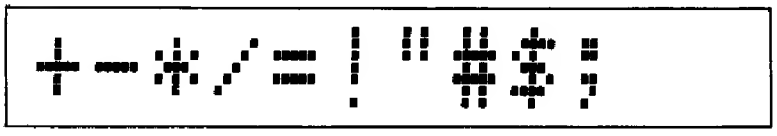
1-2 How to Read the Display



The display shows the calculation value or result. A character may take up an area on the display composed of 5 horizontal and 7 vertical dots. A maximum of 12 positions are available for display of numbers or characters. (Zero is displayed as Ø.) However, if a formula or statement exceeds 12 positions, the numbers or characters will move to the left — a maximum of 62 characters can be input.
The blinking cursor is displayed until 55 characters have been input. From the 56th character on, a blinking " ▮ " will be displayed instead.
A 4-position numerical display on the upper portion of the display indicates the number of steps remaining.
In addition a "—" (dash) will be displayed to the right of the 4-position numerical display during operation.
Also, in the Shift In mode, abbreviations for angular units such as "DEG", "RAD" and "GRA" will be displayed. Similarly, "RUN" (RUN mode), "WRT" (WRT mode), "TR" (TR mode), "PRT" (PRT mode), and "STOP" will be displayed to indicate the current mode of operation.

- **Alphabet display example**

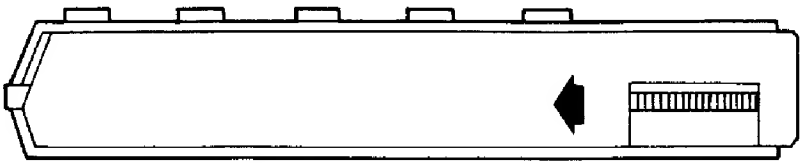
- **Symbol display example**



Chapter 2
Prior to Calculating

2-1 Contrast Adjustment

To adjust the display contrast use the control located on the right side of the computer.



Turn in the direction of the arrow to increase contrast. Turn in the opposite direction to reduce contrast.

2-2 RAM Expansion Pack (optional)

The PC-4 comes with a standard RAM area of 544 possible steps and 26 memories. However, this can be increased to a maximum of 1,568 possible steps and 222 memories with the optional RAM Expansion Pack (Cat. No. 26-3653A). This expanded RAM area can be used the same as the standard area besides permitting step number increase and memory expansion (Refer to page 12).

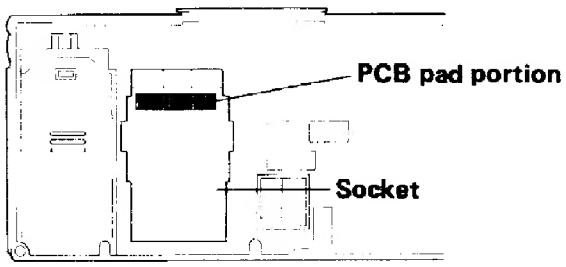
• How to install the RAM Expansion Pack

Note: The internal circuitry of the RAM Expansion Pack may be damaged by static electricity. Therefore , before handling the pack ground yourself to discharge any static electricity by touching a metallic object such as a doorknob.

(procedure)

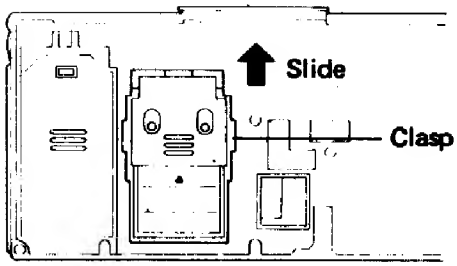
(1) Turn the power switch off.

(2) Loosen the two screws on the back and remove the rear panel.



(3) Insert the pack into the socket on the computer body and slide the clasp into a locked position.

*Never touch the connector portion of the RAM pack or the PCB pad portion of the computer body.



(4) Replace the rear panel and tighten the screws.

- After installing or removing the RAM pack, be sure to turn the power on and press the ALL RESET button with a pointed object.
  If the ALL RESET button is not pressed, the memory contents may be changed or a meaningless display may be shown.
- Do not allow the connector portion of the pack or the PCB pad portion of the computer body to become dusty or dirty, and avoid getting fingerprints on them as this will cause poor contact.
- Be sure to place the removed pack in its case and store in a location where it is not subject to dust or dirt.

2-3 Memory Expansion

There are normally 26 memory units (variables). The number of steps at this time is 544. The maximum number of standard memory units is 94. Using the RAM Expansion Pack the number of memory units can be expanded to 222. For memory expansion, program steps are converted to memory using 8 steps per memory.

Number of Memory Units	Number of Program Steps	
	Standard	Expanded
26	544	1568
27	536	1560
28	528	1552
⋮	⋮	⋮
46	384	1408
⋮	⋮	⋮
94	0	1024
⋮	⋮	⋮
200	–	176
⋮	⋮	⋮
222	–	0

Memory expansion is performed in units of 1 using a DEFM command.

Example:
Expand by 30 and make 56.

Operation:
Select the RUN mode (press MODE 0) or the WRT mode (press MODE 1).

DEFM 30 EXE

```
***VAR:56
```

* DEFM can be input by pressing D E F M or by pressing SHIFT DEFM V .

A DEFM command is also used to confirm the number of memories which are currently designated.

Example:
A total of 56 memories are designated.

Input DEFM EXE

```
***VAR:56
```

- If a designation is attempted when a large number of program steps are already in use, ERR 1 appears on display to indicate there is an insufficient number of available steps and to protect the existing program. (ERR 1 ..... insufficient number of steps)
- The exclusive character variable ($) is not counted when designating since it is a special memory.

2-4 Auto Power Off

This is an automatic energy-saving function which prevents power consumption when you forget to turn off the power switch. Approximately 7 minutes after the last key operation (except during program execution), power will go off automatically.
Power can be resumed by pressing the AC Key or turning the power switch off and then on again.

* Even if power is turned off, memory contents and program contents will not be erased. However, angular unit designations and mode designations ("WRT", "TR", "PRT", etc.) will be erased.

Chapter 3
How to Calculate

Manual calculation and program calculation are performed in the "RUN" mode. (Press MODE ⊡ and RUN will be displayed.)
"DEG", "RAD" and "GRA", only apply to angular units and their display has no effect for a calculation which has nothing to do with angular units.

3-1 Calculation Priority Sequence (True Algebraic Logic)

The PC-4 has a built in Calculation Priority Sequence and will perform calculations based on that sequence.
The Calculation Priority Sequence is determined as follows.

① Functions (SIN, COS, TAN, etc.)
② Power
③ Multiplication and division (* and /)
④ Addition and subtraction (+ and −)

When the priority is the same, calculation will begin from the left. However, when parentheses are used, they get the highest priority.

Example:

$$2+3*\mathrm{SIN}\ (17+13)\uparrow 2=2.75$$

① ② ③ ④ ⑤

3-2 Input/Output and Operation Number of Positions

The PC-4 can sustain 12 input positions for the mantissa portion and 2 positions for the exponential portion. Internal operations are also performed using 12 positions for the mantissa portion and 2 positions for the exponential portion. The range extends from 1×10^{-99} to $\pm 9.99999999999 \times 10^{+99}$ and 0.
The number of output positions is 10 for the mantissa portion and 2 for the exponential portion. However, if an exponential portion is attached, the mantissa portion will be 8 positions.

* For function results, when the number of display positions (12 positions) is exceeded, up to 12 positions will be displayed, including Ø and the decimal point.

Example:

$(1\times10^5)\div7=14285.71429$	1 [E] 5 [÷] 7 [EXE]	14285.71429
$(1\times10^5)\div7-14285=0.7142857$	1 [E] 5 [÷] 7 [−] 14285 [EXE]	0.7142857

When the calculation result exceeds 10^{10} (10,000,000,000) or goes below 10^{-3} (0.001), it is automatically displayed using an exponential display.

Example:

$1234567890\times10=12345678900$ $(=1.23456789\times10^{10})$	1234567890 [×] 10 [EXE]	1.2345678_E10 (E: Exponential sign)

* The exponential portion is displayed along with an exponential sign following the mantissa portion.

$1.234\div10000=0.0001234$ $(=1.234\times10^{-4})$	1.234 [÷] 10000 [EXE]	$1.234_E{}^-04$

3-3 How to Perform Fundamental Calculations

(1) Calculation symbols and function commands

Calculation symbols used in BASIC include the "+" and "−" signs used for addition and subtraction. However, for multiplication and division, "✱" and " / " are used instead of " x " and " ÷ ".

Example:

2 + 3 − 4 x 5 ÷ 6 becomes 2 + 3 − 4 ✱ 5 / 6

The calculation functions available with the PC-4 are as follows:

Function Name		Form
Trigonometric function	sin x	SIN x
	cos x	COS x
	tan x	TAN x
Inverse trigonometric function	$\sin^{-1}$ x	ASN x
	$\cos^{-1}$ x	ACS x
	$\tan^{-1}$ x	ATN x
Square root	$\sqrt{x}$	SQR x
Exponential function	e^x	EXP x
Natural logarithm	ln x	LN x
Common logarithm	log x	LOG x
Change to integer	INT x	INT x

Delete fraction from the integer portion	FRAC x	FRAC x
Change to absolute value	$\lvert x \rvert$	ABS x
Symbolize	positive number → 1 0 → 0 negative number → −1	SGN x
Round off	(round off x at 10^y)	RND (x , y)*
Random number		RAN #

* In the case of the RND function the argument must be enclosed in parentheses.

3-4 Callout of Previous Calculation Result

The result obtained by executing a manual calculation or program calculation is stored until the next calculation is executed. This result can be displayed by pressing the [ANS] Key.

Example:

741+852=1593

2431−1593=838

Operation:

741+852	741+852
[EXE]	1593
2431−[ANS]	2431−1593
[EXE]	838

Also, the numerical value which is displayed following a calculation can be used in the next calculation just as it is.

Example:

25.3+13.9=39.2

39.2×7.6=297.92

25.3+13.9[EXE]	39.2
×7.6	39.2*7.6
[EXE]	297.92

3-5 Error Messages

If the formula or substitution statement do not conform to BASIC grammar or if the calculation range of the computer is exceeded, an error will occur during execution and an error message will be displayed. The following error messages are displayed for manual calculation.

ERR2	(Syntax error)
ERR3	(Mathematical error)

The following error messages are displayed for program calculation.

ERR2 P0–10	(A syntax error has occurred on line 10 of program P0.)
ERR3 P2–30	(A mathematical error has occurred on line 30 of program P2.)

(Refer to page 61 for an explanation of error messages.)

* If the calculation result exceeds $\pm 9.99999999999 \times 10^{+99}$, an overflow will occur and an ERR 3 error message will be displayed. Also, if the result is less than 1.0×10^{-99}, an underflow will occur and the calculation result will become 0.

3-6 Key Operation

For manual calculation as well as for program calculation and program write-in, key operation is performed as follows.

(1) Alphabetical Input

Example: Input ABC

Operation: [A][B][C]

ABC

Example: Input SIN

Operation: [S][I][N]

SIN

- **Numerical input**

Example: Input 123

Operation: [1][2][3]

123

Example: Input 96.3

Operation: [9][6][·][3]

96.3

- **Symbol input**

Example: Input $#?

Operation: [SHIFT][4] [SHIFT][3] [SHIFT][/?]

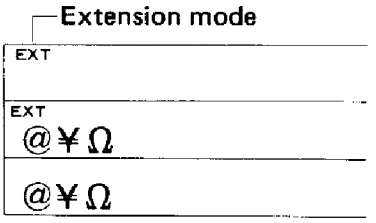
Example: Input @¥Ω

Operation:

[MODE][•].... (extension mode designation)

[SHIFT][E] [SHIFT][R] [SHIFT][N]

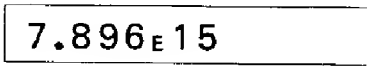
[MODE][•].... (extension mode release)



- **Input of numerical value with exponent**

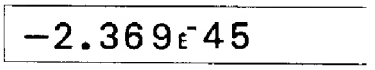
Example: Input 7.896 x 10^{15}

Operation: [7][•][8][9][6][E][1][5]



Example: Input -2.369×10^{-45}

Operation: [−][2][•][3][6][9][E][−][4][5]

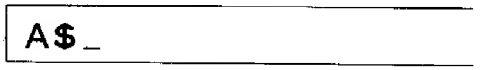


(2) Changing Input Contents (Correction, Deletion and Insertion)

- **Correction**

Move the cursor to the location to be corrected using arrow keys ([←] and [→]) then press the correct character, number or symbol.

Example: Correct "A$" to "B$".



Operation: Move the cursor two character positions to the left.

[←][←]

Press the [B] Key.

Example: Correct "LIST" to "RUN".

Operation: Move the cursor 4 character positions to the left.

[←][←][←][←]

Press [R][U][N][SPC] or [SHIFT][RUN] .

- **Deletion**

Move the cursor to the position to be deleted and press the [DEL] Key. Each time the key is pressed, one character is deleted and the characters to the right move one position to the left.

Example: Delete one of the "I" characters from "SIIN".

SIIN_

Operation: Move the cursor 2 character positions to the left.

[←][←]

Press [DEL] .

SIIN
SIN

Example: Delete "X," from "INPUT X, Y".

INPUT X,Y_

Operation: Move the cursor 3 positions to the left.

[←][←][←]

Press [DEL][DEL] .

INPUT X,Y
INPUT Y

- **Insertion**

Move the cursor to a position located just to the right of the character after which you want to make an insertion. At that position, press [SHIFT][INS] and one character space will be opened up. Then press the desired character, number or symbol key.

Example: Change "T=A$" to "T$=A$".

T=A$_

Operation: Move the cursor 3 character positions to the left.

[←][←][←]

Press [SHIFT][INS] and open up one character space.

Press [SHIFT][$] .

T=A$
T_=A$
T$=A$

Example: Change "PRINT X" to "PRINT SIN X".

PRINT X_

Operation: Move the cursor 1 character position to the left.

[←]

Press [SHIFT][INS][SHIFT][INS][SHIFT][INS].

Press [S][I][N] .

PRINT X
PRINT _ X
PRINT SINX

The above are methods for changing input contents.

Chapter 4
Manual Calculation

4-1 What Is Manual Calculation?

Manual calculations are not made automatically by storing calculation formulas as a program.
Instead, the calculations are performed manually by substituting the calculation on the right side of the numerical formula for the left side or by calling out the contents of the variable.

4-2 Operation Method for Manual Calculation

- Addition, subtraction, multiplication and division are performed by true algebraic logic operations. [+], [−], [×] (x), [÷] (÷) and [EXE] (=) are used respectively.
  The [EXE] Key is used to obtain the calculation result.

Example: 12+36−9×5÷4=36.75

Operation:

[1][2][+][3][6][−][9][×][5][÷][4]

[EXE]

12+36−9*5/4
36.75

- Calculations involving functions are performed in the same manner as a normal formula. Data which may include addition, subtraction, multiplication and division operations is written in following the function command.

Example: log 1.23=0.0899051114

Operation:

LOG 1.23

[EXE]

LOG1.23
0.0899051114

* In this manual, the frames around letters and numbers will be omitted.

Example: [S][I][N][(][1][5][+][8][)][EXE] → SIN [SHIFT] (15 + 8 [SHIFT]) [EXE]

- When storing a numerical value or a calculation result, letters A through Z of the alphabet, or a combination of letters and numbers (when used as an array), can be used as totalling variables to operate as memories.
  A substitution formula is used to convert a numerical value or a calculation result into a variable.

Example: Store 1234 in variable A.

Operation: A (=) 1 2 3 4 EXE

```
A=1234
_
```

Example: Add the result of 23 x 56 to variable K.

Operation: K (=) K + 2 3 × 5 6 EXE

```
K=K+23*56
_
```

This manually performed method is similar to a substitution statement in a program.

* Prior to pressing the EXE Key, corrections can be made by moving the cursor to the position to be corrected and pressing the desired key.
(Refer to page 18.)
* To clear the entire display, press AC .

4-3 Manual Calculation Examples

4-3-1 How to Perform Fundamental Calculation

- **Addition, Subtraction, Multiplication and Division Calculation**

Example: 23+4.5−53=−25.5

Operation: 2 3 + 4 . 5 − 5 3 EXE

```
-25.5
```

Example 56×(−12)÷(−2.5)=268.8

Operation: 5 6 × (−) 1 2) ÷ (−) 2 . 5) EXE

```
268.8
```

Example: 12369×7532×74103=6.9036806×10^12 (=6903680600000)

Operation: 1 2 3 6 9 × 7 5 3 2 × 7 4 1 0 3 EXE

```
6.9036806E12
```

Example: 1.23÷90÷45.6=2.9970760×10^-4 (=0.00029970760)

Operation: 1 . 2 3 ÷ 9 0 ÷ 4 5 . 6 EXE

```
2.9970760E-04
```

* When the result exceeds 10^{10} (10,000,000,000) or is less than 10^{-3} (0.001), it will be displayed exponentially.

Example: 7×8+4×5=76

Operation: 7 × 8 + 4 × 5 EXE

```
76
```

Example: 12+(2.4×10^5)÷42.6−78×36.9=2767.602817

Operation 1 2 + 2 . 4 (E) 5 ÷ 4 2 . 6 − 7 8 × 3 6 . 9 EXE

```
2767.602817
```

- **Memory calculation**

Example: $\underline{12}\times45=540$

$\underline{12}\times31=372$

$75\div\underline{12}=6.25$

Operation:

A(=)12[EXE]	_
A[×]45[EXE]	540
A[×]31[EXE]	372
75[÷]A[EXE]	6.25

Example

$23+9=32$

$53-6=47$

$-)45\times2=90$

$99\div3=33$

Total 22

Operation:

M(=)23[+]9[EXE]	
M(=)M[+]53[−]6[EXE]	
M(=)M[−]45[×]2[EXE]	
M(=)M[+]99[÷]3[EXE]	
M[EXE]	22

* In this calculation method the results of the respective calculations are not known, yet they are converted to M. When you want to see the calculation results, use the following method:

23[+]9[EXE]	32
M(=)[Ans][EXE]	
53[−]6[EXE]	47
M(=)M[+][Ans][EXE]	
45[×]2[EXE]	90
M(=)M[−][Ans][EXE]	
99[÷]3[EXE]	33
M(=)M[+][Ans][EXE]	
M[EXE]	22

4-3-2 How to Perform Function Calculation

- **Trigonometric functions (sin, cos, tan) and inverse trigonometric functions ($\sin^{-1}$, $\cos^{-1}$, $\tan^{-1}$)**

When using trigonometric or inverse trigonometric functions, be sure to designate the angular unit.

Example: sin 12.3456° = 0.2138079201

Operation: MODE 4 → "DEG"

SIN 12.3456 EXE → 0.2138079201

Example: 2·sin45° × cos65.1° = 0.5954345575

Operation: 2 × SIN 45 × COS 65.1 EXE → 0.5954345575

Example: $\sin^{-1}0.5 = 30°$

Operation: ASN 0.5 EXE → 30

Example: $\cos(\frac{\pi}{3}\text{rad}) = 0.5$

Operation: MODE 5 → "RAD"

COS SHIFT ↓ SHIFT π ÷ 3 SHIFT ↓ EXE → 0.5

Example: $\cos^{-1}\frac{\sqrt{2}}{2} = 0.7853981634\text{rad}$

Operation: ACS SHIFT ↓ SQR 2 ÷ 2 SHIFT ↓ EXE → 0.7853981634

Example: tan(−35gra) = −0.612800788

Operation: MODE 6 → "GRA"

TAN − 35 EXE → −0.612800788

- **Logarithmic functions (log, ln) and exponential functions (e^x, x^y)**

Example: log 1.23 (= $\log_{10}$1.23) = 0.0899051114

Operation: LOG 1.23 EXE → 0.0899051114

Example: ln 90 (= $\log_e$90) = 4.49980967

Operation: LN 90 EXE → 4.49980967

Example: $e^{-3} = 0.0497870683$

Operation: EXP −3 EXE → 0.0497870683

Example: $10^{1.23}=16.98243652$

(To get the antilogarithm of common logarithm 1.23)

Operation: 10 [SHIFT] [↑] 1.23 [EXE]

16.98243652

Example: $5.6^{2.3}=52.58143837$

Operation: 5.6 [SHIFT] [↑] 2.3 [EXE]

52.58143837

Example: $123^{\frac{1}{7}}\left(=\sqrt[7]{123}\right)=1.988647795$

Operation: 123 [SHIFT] [↑] [SHIFT] [↓] 1 [/] 7 [SHIFT] [↑] [EXE]

1.988647795

Example: log sin40° + log cos35° = −0.278567983

The antilogarithm is 0.5265407845 (logarithmic calculation of sin 40° x cos 35°)

Operation: [MODE] [4] → "DEG"

LOG SIN 40 [+] LOG COS 35 [EXE]

−0.278567983

10 [SHIFT] [↑] [ANS] [EXE]

0.5265407845

- **Other functions (√, SGN, RAN #, RND, ABS, INT, FRAC)**

Example: $\sqrt{2}+\sqrt{5}=3.65028154$

Operation: SQR 2 [+] SQR 5 [EXE]

3.65028154

Example: Give "1" to a positive number, "−1" to a negative number, and "0" to a zero.

Operation: SGN 6 [EXE]

1

SGN 0 [EXE]

0

SGN [−] 2 [EXE]

−1

Example: Random number generation (pseudo random number of 0 < RAN# < 1)

Operation: RAN [SHIFT] [#] [EXE]

0.790373907

(Example)

Example: The result of 12.3×4.56 is rounded off at 10^{-2}.

12.3×4.56=56.088

Operation: RND [SHIFT] [↑] 12·3 [×] 4·56 [SHIFT] [↑] [−] 2 [SHIFT] [↑] [EXE]

※ For RND (x, y), y is $|y|<100$

56.1

Example: $|-78.9 \div 5.6| = 14.08928571$

Operation: ABS [SHIFT] [(] [−] 78·9 [÷] 5·6 [SHIFT] [)] [EXE]

14.08928571

Example: The integer portion of $\frac{7800}{96}$ is 81.

Operation: INT [SHIFT] [(] 7800 [÷] 96 [SHIFT] [)] [EXE]

81

* This function obtains the maximum integer which does not exceed the original numerical value.

Example: The decimal portion of $\frac{7800}{96}$ is 0.25.

Operation: FRAC [SHIFT] [(] 7800 [÷] 96 [SHIFT] [)] [EXE]

0.25

- **Designation of Number of Effective Positions and of Number of Decimal Positions**

Designation of number of effective positions and number of decimal positions is performed using a "**SET**" command.

Designation of number of effective positions ..... SET En (n = 0 through 8)
Designation of number of decimal positions ..... SET Fn (n = 0 through 9)
Designation release ..... SET N

* When the designation of the number of effective positions is "SET E 0", the number of positions is 8.
* The last designated position will be displayed rounded off.

Furthermore, the original numerical values will remain inside the computer and in the memory.

Example: $100 \div 6 = 16.66666666\cdots\cdots$

Operation: SET E 4 [EXE] (designates 4 effective positions)

100 [÷] 6 [EXE]

1.667E01

Example: $123 \div 7 = 17.57142857\cdots\cdots$

Operation: SET F 2 [EXE] (designates 2 decimal positions)

123 [÷] 7 [EXE]

17.57

Example: $1 \div 3 = 0.3333333333\cdots\cdots$

Operation: SET N [EXE] (releases the designation)

1 [÷] 3 [EXE]

0.3333333333

4-4 Arrays

One-dimensional arrays are used with letters attached such as A(*i*), B(*j*), etc. Since these arrays are used both with the normal 26 memories and with expanded memories, pay attention to the following array arrangement.

A=A(0)
B=A(1)=B(0)
C=A(2)=B(1)=C(0)
D=A(3)=B(2)=C(1)=D(0)
E=A(4)=B(3)=C(2)=D(1)=E(0)
⋮
Y=A(24)=B(23)=C(22)·····=Y(0)
Z=A(25)=B(24)= ·····=Y(1)=Z(0)
A(26)=B(25)= ·····=Y(2)=Z(1)
A(27)=B(26)= ·····=Y(3)=Z(2)
Expanded memories
⋮
A(93)=B(92)= ·····=Y(69)=Z(68)

When arrays are used in this manner, since the same memory may be used depending on the array argument, avoid using the same memory in the same program.

Example:

Can be used at the same time ..... A, B, C, F(0), F(9)
Cannot be used at the same time ..... F, G, A(5), A(6)

Perform memory expansion correctly according to the size of the array.

Chapter 5
Program Calculation

5-1 Program Outline

Program calculation is a method for:
① Programming the calculation or formula to be executed.
② Storing the program in the computer.
③ Obtaining the result automatically by simply inputting data in the program.

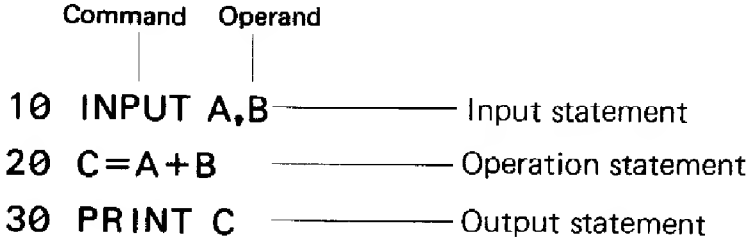
Let's examine the programming concept and procedure required to process a given problem using the computer.

- **Programs and Programming**

When computer users process a problem, they compose instructions which are written in a language that the computer can understand. These instructions are called a "program" and composing these instructions is known as "programming".

- **What is a program?**

In order to make a program, there are various rules or grammar. This will be explained later in detail. At this time let's take a look at an example of a simple, fundamental program to see what it looks like.



The above is a fundamental program which consists of an input statement, an operation statement, an output statement, and line numbers. An input statement is used to enter the data. An operation statement is used to process that data. An output statement is used to retrieve the execution result. Line numbers are used at the beginning of each line. The operation statement can include judgment statements and cover many lines to make a long and complex program. Also following the line number, a line consisting of one word appears. This word is called a "command" and it tells the computer what to do next. Following this command is a character string which contains information required to process the command. This is called the "operand".

- **How to Count the Number of Steps**

A command or a function command in a program uses 1 step.
A line number (numerical values from 1 through 9999) uses 2 steps.

Example:

```
1 INPUT A EXE ---------- 5 steps
2     1   1   1

10 B=SIN A EXE ---------- 7 steps
2  1 1  1  1  1

100 PRINT "B=" ; B EXE ---------- 10 steps
2       1     4   1 1 1

                        Total 22 steps
```

5-2 Program Fundamentals

5-2-1 Constants and Variables

Characters which can be used in BASIC are capital letters (A through Z) and numbers (Ø through 9) and certain special characters such as symbols, etc.

- **Constants**

The characters used in BASIC are capital letters (A through Z), and numbers (Ø through 9), and certain special characters such as symbols.

Example: $S=\pi r^2$ becomes S=π∗R↑2
2 is the constant.

- **Variables**

A variable is a single capital letter (A through Z) or a single capital letter with "$" attached (character variable).
Variables are also numerical values which are used in a program. They are used during execution to make inputs from the keyboard or to substitute calculation results which were initially unknown.

Example: $S=\pi r^2$ becomes S=π∗R↑2
R is the variable.

Example:

```
Y = 2 ∗ X ↑ 2 + 3 ∗ X + 4
|   |   |   |   |   |   |
Variable | Variable | Constant | Constant
    Constant    Constant    Variable
```

In other words, algebraic terms are "variables" and constant numbers are "constants". In addition, there are character constants and character variables.
A character constant is a character string which is written directly. A character string is a group of characters which is enclosed in quotation marks such as "123" or "ABC".

A character variable is not a numerical value — although it may consist of numbers — but a variable which contains a character string. In other words, "123" just happens to be 1 and 2 and 3 in sequence and is considered the same as "ABC". A character variable is made by attaching a "$" to a regular variable (A, B, X, Y, etc.).

Example: A$,B$,C$,X$,Y$

Comparison or addition of each character variable is possible. Other operations such as subtraction, multiplication and division, however, cannot be performed.

Example: If A$ = "123" and B$ = "456"

As a result of C$ = A$ + B$, C$ becomes "123456".
(For C$ = B$ + A$, C$ becomes "456123".)

A character variable can contain up to 7 characters.
In addition to these character variables, there is also an exclusive character variable. The exclusive character variable is "$" and can contain up to 30 characters.

Example: $= "1234567890ABCDEFG"

Since this exclusive character variable can use a character function (MID function) which will be explained later, it is much more convenient than other character variables.

* Numerical variables and character variables which contain the same letter cannot be used at the same time since they use the same memory.

For example:

Numerical variable A ┐
Character variable A$ ┘ Cannot be used at the same time.

5-2-2 Substitution Statements

BASIC substitution statements adhere to the following format:

Variable = numerical expression

In a BASIC substitution statement, the right side which may contain addition, subtraction, multiplication or division is called a "numerical expression".

Example: Y=2*X+3

In Y = 2*X+3, the left side is the variable and the right side is the numerical expression.
The "=" does not mean "equal", it means "substitute".
In other words, the meaning is different from normal mathematics where "the left side (Y) and the right side (2*X+3) are equal".
It means "input the operation result of the right side (2*X+3) into the left side (Y)".
It may be easier to understand by thinking of Y = 2*X+3 as Y ← 2*X+3.

5-3 Program Writing and Execution

5-3-1 Program Writing

Storing a program in the computer memory is called "program writing".
This operation is performed through key input as follows.

1. Designate the WRT mode.
2. Designate the program area.
3. Input the program in line units (write-in).

There are 10 program areas, namely, P0 through P9. Programs can be written in any of these program areas.

(1) WRT mode designation

Since program writing is performed in WRT mode, press [MODE] [1] , and WRT will be displayed.

(2) Program area designation

For program area designation, press the [SHIFT] Key then press a numerical key from [0] through [9].

[SHIFT] [0] (P0) → P0
[SHIFT] [1] (P1) → P1
[SHIFT] [2] (P2) → P2
[SHIFT] [3] (P3) → P3
[SHIFT] [4] (P4) → P4
[SHIFT] [5] (P5) → P5
[SHIFT] [6] (P6) → P6
[SHIFT] [7] (P7) → P7
[SHIFT] [8] (P8) → P8
[SHIFT] [9] (P9) → P9

(3) Program input (write-in)

Program writing is performed in line number units. Up to 62 characters, including the line number, can be written in. Press [EXE] at the end of the line.

- **The role of the [EXE] Key**

The [EXE] Key is pressed for program writing, data input, and for obtaining the result of a manual calculation. The [EXE] Key must also be pressed after making changes, additions or deletions to the stored program. Even when the characters on the display change, if the [EXE] Key is not pressed immediately after correction, the stored contents will remain unchanged.

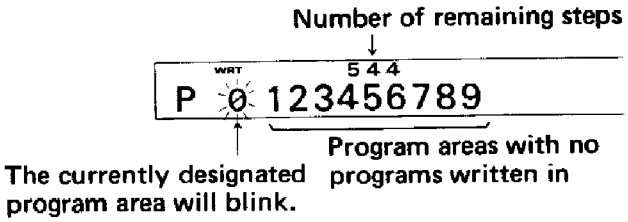
Example: Write the following program in P0.

```
10 INPUT A,B
20 V=A+B
30 W=A-B
40 PRINT V,W
50 END
```

Operation:

① Designate the WRT mode.

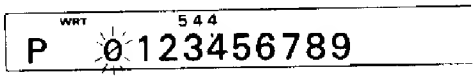
MODE 1



* This display varies depending on the number of memories or the size of the written program.
* The area numbers will not be displayed for those areas where programs have already been written.

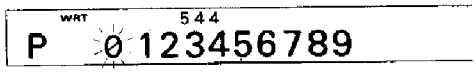
② Designate program area P0.

P0



③ When a previous program remains, clear it.
(Not required if nothing is written.)

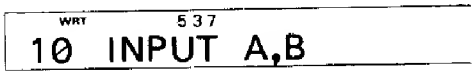
CLEAR EXE



* To clear all the program areas (P0 through P9), press C L E A R A EXE.

④ Write line 10.

10␣INPUT␣A,B EXE

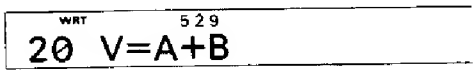


Be sure to press at the end of the line.

Means one character space (May be omitted)

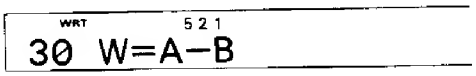
⑤ Write line 20.

20␣V =A+B EXE



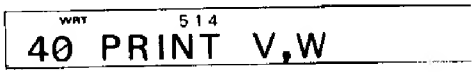
⑥ Write line 30.

30␣W=A−B EXE



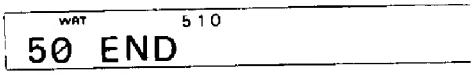
⑦ Write line 40.

40␣PRINT␣V,W EXE



⑧ Write line 50.

50␣END EXE



- When the program is complete, write an "END" command. This is not required in the above program but when a GOTO statement or GOSUB statement is used, be

sure to use it to clearly designate the end location.

- The spacing between the line numbers and commands and between commands and operands, facilitates reading the display. In BASIC language the spacing has no special meaning (except for a PRINT statement message) and may normally be omitted.
- In this program, line numbers have been divided into increments of 10 but they may be freely used within a range of 1 through 9999. However, it is more convenient for subsequent addition/insertion if they are divided into increments of 10.
  Since program execution is performed in sequence from lower numbers to higher numbers, use line numbers in the desired execution sequence.
- To clear the program in one program area, use a CLEAR command. To clear all the programs in areas PØ through P9, use a CLEAR A command.

5-3-2 Program Execution

Program execution is performed in the RUN mode. (Press MODE 0 and "RUN" will be displayed.)
There are 2 methods for executing a program which has been written.

1. Program execution method

① Execution using program area designation

For this method, execution begins as soon as the program area is designated.

SHIFT { P0 0 / ⟩ / P9 9 } (Press SHIFT then press the desired program area.)

Example: To start the program in the previous example

Operation: SHIFT P0 0

RUN mode
(omitted hereafter)

```
? RUN
```

* This "? " is displayed because an INPUT statement is written in the program as the first step.

② Execution using a RUN command

RUN EXE ("RUN" may be input by pressing either R U N EXE or SHIFT RUN B EXE .)

```
?
```

* When performing Execution using a RUN command as in the previous example, a "? " is displayed. When the program is in an input await condition, "? " will not be released even if AC is pressed. You must press MODE 0 then perform operation ② to re-input data.
Also, to begin execution in the middle of the program, input the desired line number after the RUN command and press the EXE Key.

Example: To start from line 20.

Operation: RUN 20 EXE

* For method ①, it is not necessary to designate the program area to be executed. However, for method ②, it is necessary to designate the program area to be executed. (If the program area is different, the program written in that program area will be executed.)

2. Key input during program execution

Key input may be performed during program execution using an INPUT statement and KEY function. Key input using the KEY function is only 1 key input but even if there is no key input, execution will continue. For key input using an INPUT statement, a "? " will be displayed and the program will stop in an input await condition. Execution will resume by pressing the EXE Key after data input.

Example: Execute the program written in P0 in the previous example.

Operation:

- **To execute the program**

  SHIFT P0

  ```
  ?
  ```

- **Since 2 variables are input, first, input the value of variable A.**

  47 EXE

  ```
  ?
  ```

- **Next, input the value of variable B.**

  69 EXE

  EXE

  ```
  116
  -22
  ```

In this manner, data is input during execution using the input statement data EXE .

Incidentally operations such as manual calculation can be performed during an input await condition.
Also if you want to stop program execution while in an input await condition, press MODE .

5-4 Program Editing

- Program editing consists of changes, additions, or deletions in one or various lines, or even rearranging the order of the program to allow for logical execution.
- Program editing is performed by calling out each line using a LIST command.
- The LIST command can be used in both the RUN mode and the WRT mode. When used in the RUN mode, the program contents will be displayed and when used in the WRT mode, it will permit program editing.

1. Program list display in the RUN mode

Operation:

LIST EXE

(LIST may be input by pressing L I S T EXE or SHIFT LIST EXE.)

```
10 INPUT A,B
20 V=A+B
30 W=A-B
40 PRINT V,W
50 END
READY P0
```

..... Displayed for approximately 2 seconds (same for the following)

If you do not want to call out program lines from the beginning, designate the line number where you would like to begin.
To list from line 30

Operation:

LIST 30 EXE

```
30 W=A-B
40 PRINT V,W
50 END
READY P0
```

* During LIST command execution, each program line will be displayed sequentially. If you want to stop in a particular line press the STOP Key.
To resume the LIST command, press the EXE Key.

2. Program change/addition/deletion in the WRT mode

Designate the WRT mode by pressing MODE 1 .

① Change

Each time the EXE Key is pressed, one line will be displayed starting from the line which was designated using the LIST command.
If the line number designation is omitted, the display will automatically begin from the first line.

a. Partial change

Example: Change the "+" on line 20 of the previous example to "✱".

Operation:

- **If the P0 program area is not designated, designate P0.**

SHIFT P0

```
                510
P 123456789
```

Blinking means that a program is written and this is the currently designated program area.

- **Call out line 20 using a LIST command.**

LIST 20 EXE

```
20 V=A+B_
                510
```

- **Move the cursor below the "+".**

◁ ◁

```
20 V=A±B
                510
```

* If cursor movement keys (◁ and ▷) remain pressed for more than 1 second, the cursor will move quickly and continuously.

- **Make the change.**

✱ EXE

```
30 W=A−B_
                510
```

* Be sure to press the EXE Key. If it is not pressed, only the display will change but the program will remain unchanged.

- **Press AC to release the change condition.**

AC

```
_
                510
```

* Since any other key operation will result in an unnecessary change being made, avoid pressing any other keys besides the EXE and AC Keys.

Let's list the program and check the change.

MODE

LIST EXE

```
READY P0
10 INPUT A,B
20 V=A✱B
30 W=A−B
40 PRINT V,W
50 END
READY P0
```

b. Complete change of one line

Example: Change "W = A – B" on line 30 to "W = V/2".

Operation: MODE 1

```
                    510
P 123456789
```

- **Write the new line 30.**

  30 ␣ W = V / 2 EXE

```
30 W=V/2
          510
```

- **Confirm the program list.**

  MODE 2

  LIST EXE

```
READY P0
10 INPUT A,B
20 V=A*B
30 W=V/2
40 PRINT V,W
50 END
READY P0
```

② Addition

Addition may be made in line units by writing new lines between existing lines.

Example: Add "U = V * 2" between line numbers 30 and 40 of the previous example and change line 40 to "PRINT V, W, U".

Operation: MODE 1

```
                    510
P 123456789
```

- **Input line number 35 to make input between line numbers 30 and 40.**

  35 ␣ U = V * 2 EXE

```
35 U=V*2
          502
```

* For inputting between line numbers 30 and 40, line numbers may be freely selected in the range from 31 through 39.

- **To change line 40, call it out using a LIST command and add ",U".**

  LIST 40 EXE

  ⇨ SHIFT ␣ U EXE

  AC

```
40 PRINT V,W
          502
50 END
          500
_
          500
```

Let's list the program to confirm the additions.

MODE ⊘

LIST EXE

```
READY P0
10 INPUT A,B
20 V=A*B
30 W=V/2
35 U=V*2
40 PRINT V,W
PRINT V,W,U
50 END
READY P0
```

③ Deletion

a. Partial deletion

Example: Delete "V," from line 40 of the previous example.

MODE 1

```
P 500
123456789
```

- **Call out line 40 using a LIST command and move the cursor below the "V".**

LIST 40 EXE

```
40 PRINT 500
V,W
```

◁ ◁

```
40 PRINT 500
V,W
```

- **Delete "V," using the DEL Key.**

DEL DEL

EXE

```
40 PRINT 500
W,U
50 END 502
```

* If the EXE Key is not pressed, the program contents will not be changed.

AC

```
502
_
```

* Be sure to press AC to release the change condition for line 50.

- **List the program to confirm the deletion.**

[SHIFT] [9]

LIST [EXE]

```
READY P0
10 INPUT A,B
20 V=A*B
30 W=V/2
35 U=V*2
40 PRINT W,U
50 END
READY P0
```

b. Complete deletion of one line

If you input the line number for the line to be cleared, the entire line will be deleted.

Example: Delete line 30.

Operation: [SHIFT] [1]

```
                    502
P 123456789
```

- **Input line number 30.**

30 [EXE]

```
                    510
_
```

- **Confirm the deletion.**

[SHIFT] [9]

LIST [EXE]

```
READY P0
10 INPUT A,B
20 V=A*B
35 U=V*2
40 PRINT W,U
50 END
READY P0
```

④ Line renumbering

Example: Write the following program in P2.

```
10 INPUT N
20 M=N↑2
30 L=N↑0.5
40 PRINT M,L
50 END
```

Move line 20 between lines 30 and 40.

Operation: [MODE] [1]

```
P _1          476
              3456789
```

- **Call out line 20 using a LIST command.**

  LIST 20 [EXE]

```
20 M=N↑2 _    476
```

- **Move the cursor below the "2" of line number "20".**

  [←][←][←][←][←][←][←][←]

```
20 M=N↑2      476
```

- **Change 20 to 35 and input.**

  35 [EXE]

```
30 L=N↑0.5 _  468
```

- **To complete the change, press [AC] and release the change condition.**

  [AC]

```
_             468
```

- **List the program to see how the contents have been changed.**

  [MODE] [2]

  LIST [EXE]

```
READY P2
10 INPUT N
20 M=N↑2
30 L=N↑0.5
35 M=N↑2
40 PRINT M,L
50 END
READY P2
```

- **In this condition, the contents on line 20 were moved between line 30 and line 40 but line 20 still remains, so delete it.**

MODE 1

20 EXE

```
P _1 3456789
   468
   476
_
```

- **This completes line renumbering. Confirm by listing the program.**

MODE ⊘

LIST EXE

```
READY P2
10 INPUT N
30 L=N↑0.5
35 M=N↑2
40 PRINT M,L
50 END
READY P2
```

5-5 Program Debug

(1) Program debug system

The debug system of the PC-4 is divided into table top debug and conversation type debug using the display.

Debug system

I. Table top debug
   - a. Complete debug
     To check logic composition of a program.
   - b. Partial debug
     To check a program by line unit.

II. Conversation type debug using the display
   This uses the automatic check function of the computer to check program execution flow and identify BASIC language errors.

Since table top debug is performed during programming, we will explain conversation type debug using the display here.

(2) Conversation type debug

If an error occurs during program execution, an error message will be shown on the display. These errors will be shown in line units and will indicate the kind of BASIC language error. Based on the error message which is shown on the display, debugging is then manually performed while conversing with the display. For the meaning of the error messages, refer to the Error Message List on page 64.

Example:

```
10 INPUT X
20 Y=X↑2+3*X+15
30 PRINT Y
40 END
```

Suppose line 20 of the above program is mistakenly input as follows.

```
20 Y=X↑2+3X+15
```

Operation:

- **If this program is executed, a "?" will be displayed as a result of the INPUT statement on line 10.**

[MODE] [⊘] RUN [EXE]

```
?
```

- **Suppose "45" is input at this time. The display would show.**

45 [EXE]

```
ERR2 P0-20
```

- **This means that "a syntax error occurred on line 20". Confirm the program contents.**

[AC] [MODE] [1]

LIST 20 [EXE]

```
P _123456789
20 Y=X↑2+3X±
```

- **The "*" was omitted between "3" and "X" on line 20. Therefore, correct it by following the procedure for program editing.**

[←] [SHIFT] [INS]

[*] [EXE]

```
20 Y=X↑2+3_X
30 PRINT Y
```

(3) Debug while executing the program

Conversation type debug is performed by obtaining information from the computer in the form of error message. However, there may be occasions when an error message is not displayed yet the calculation or program result is incorrect. In cases like that program execution can be carried progressively in steps to confirm the calculation results along the way, and thereby isolate the error.
There are two ways to do this: (1) the execution process is stopped using a STOP command; (2) execution is performed in one line units using the TR (trace) mode.

■ Debug using a STOP command

Example: Write the following program.

```
10 Y=0
20 INPUT N,X
30 FOR I=1 TO N
40 Y=Y+X↑2
50 NEXT I
60 PRINT Y
70 END
```

The value of Y, before each consecutive loop, can be viewed using a STOP statement.

Operation:

- **The STOP statement should be placed right after the calculation formula. Write a STOP statement between line 40 and line 50.**

  MODE 1

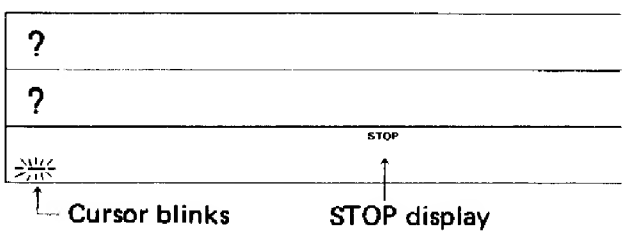
  ```
  45 STOP
  ```

- **The execution process will stop after the calculation on line 40 is completed and a check can be made then.**

  MODE ⊘ RUN EXE

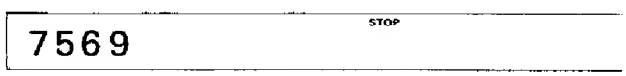
  4 EXE

  87 EXE



- **What is the value of Y at this point?**

  Y EXE



- **If the program is resumed, it will stop at the next STOP statement and the value of Y can be obtained again.**

[EXE]

Y [EXE]

```
                    STOP
_
                    STOP
15138
```

- **By repeating this operation, the calculation process can be seen.**

When assembling a complicated program, checking the process using table top debug can be very difficult. However, if the variables are checked using this kind of STOP statement, programming mistakes can be found and corrected more easily.

■ Debug using the TR (trace) mode

If program execution is performed using the TR mode (press [MODE][2]), the program will sequentially stop at each line and debugging can then be performed easily.
Let's use the TR mode to debug the example which was previously debugged using a STOP command.

Operation:

Designate the RUN mode. ····· [MODE][0]

Designate the TR mode. ····· [MODE][2]

RUN [EXE]

[EXE]

Check the execution process. ····· [STOP]

[STOP]

Continue program execution. ····· [EXE]

4 [EXE]

87 [EXE]

[STOP]

[EXE]

[EXE]

The value of Y ····· Y [EXE]

[EXE]

```
READY P0
READY TR P0
P0-10 TR                STOP
?     TR
?     TR                STOP
P0-20 TR                STOP
?                       "TR" and "STOP" will
?                       be omitted hereafter.
_
P0-20
P0-30
P0-40
7569
P0-45
```

Repeated hereafter

Debugging using the TR mode is ideal for checking the entire flow of a program and isolating mistakes that may have been made.

5-6-1 Input Command

- **Input Statement**

An input command is used to input the data during program calculation.
An input statement is used to input data into a variable using the keys during program execution or program execution stops (after display shows a "? ").

Format: INPUT ["character string",] variable [, "character string", variable]
(Items enclosed in brackets may be omitted.)

The "character string" may be omitted. However, if it is written, the characters enclosed in quotation marks will be displayed preceeding the question mark. This can be used as a message during input.
The variables following the INPUT statement can be numerical variables (A, B, etc.), character variables (X$, Y$, etc.), or the exclusive character variable ($). These can be written consecutively using a ",".

Example:

INPUT A	?
INPUT "DATA=",A	DATA=?

After an INPUT statement a "? " will be displayed and the PC-4 enters an input await condition. At this time, if data is input and the [EXE] Key is pressed, program execution will proceed to the next process.
The input await condition will not be released even if the [AC] Key is pressed. Therefore, when you want to stop a program in execution, press [MODE][ON] .

* Data which can be input using an INPUT statement include numerical values or the results (answers) of numerical expression (for numerical variables) and character strings (for character variables).

In the case of INPUT A

Numerical value ····· 123[EXE] → A=123
Result of a numerical expression ····· 14[×]25[EXE] → A=350

In the case of INPUT B$

Character string ····· ABC[EXE] → B$=ABC
789[EXE] → B$=789

Furthermore, other numerical variables can also be used as input for numerical variables.

In the case of INPUT A (make X = 987654)

Variable ····· X[EXE] ——→ A=X
=987654

- **Memory calculation**

Example: $\underline{12}\times45=540$

$\underline{12}\times31=372$

$75\div\underline{12}=6.25$

Operation:

A=12EXE	_
A×45EXE	540
A×31EXE	372
75÷AEXE	6.25

Example $23+9=32$

$53-6=47$

$-)45\times2=90$

$99\div3=33$

Total 22

Operation:

M=23+9EXE	
M=M+53−6EXE	
M=M−45×2EXE	
M=M+99÷3EXE	
MEXE	22

* In this calculation method the results of the respective calculations are not known, yet they are converted to M. When you want to see the calculation results, use the following method:

23+9EXE	32
M=ANSEXE	
53−6EXE	47
M=M+ANSEXE	
45×2EXE	90
M=M−ANSEXE	
99÷3EXE	33
M=M+ANSEXE	
MEXE	22

The output control function following the PRINT statement is a CSR function, which designates the location where the following data is to be displayed.
For the numerical expression, a variable or calculation formula is written. In the case of a variable, the contents will be displayed. In the case of a calculation formula, the result will be displayed.

Example:

PRINT A (make A = 12345)	12345
PRINT 789	789
PRINT A*2 (make A = 147)	294
PRINT B$ (make B$ = "PB-100")	PB-100

In the case of a character expression, the characters enclosed in quotation marks will be displayed.

Example:

PRINT "ABC"	ABC
PRINT "XYZ" + "123"	XYZ123

The numerical expressions or character expressions may be written consecutively by using a ";" (semicolon) or "," (comma). However, the number of characters which can be written on one line cannot exceed 62, including the line number. The number of characters in the character string enclosed in quotation marks cannot exceed 30.
The difference between the ";" and the "," is that with the ";" the numerical expression or character expression will be displayed following the previous expression and with the ",", the display will go off once and then the numerical expression will appear next.
When a ";" is not written after the data, "STOP" will be displayed after the data is displayed, and program execution will stop. Therefore, when you want to display the following data or continue program execution, press the EXE Key.

- **CSR function**

The CSR function is an output control function which designates the location where the data is to be displayed.

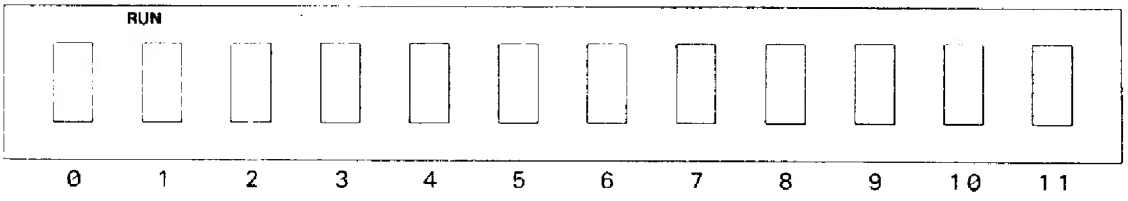
Format: PRINT CSR numerical expression* [{ , / ; } { numerical expression / character expression } .....]

Either one of the items enclosed in { } can be used.

Items enclosed in [ ] can be omitted.

* The value of the numerical expression can vary from 0 to 11.

Using the value of this numerical expression, a position on the display can be designated as the starting place for data to appear.
The method for counting the positions on the display is shown below.



Example:

```
PRINT A          (make A=12345)
PRINT CSR 1;A
PRINT CSR 5;A
PRINT B$         (make B$ = ABCDE)
PRINT CSR 2;B$
PRINT CSR 10;B$
```

```
12345
 12345
     12345
ABCDE
 ABCDE
       AB
     ABCDE
```

* If a "," (comma) is used instead of a ";" (semicolon) following the CSR function, the display will be cleared once and then successive displays will begin from the left by using the EXE Key.

5-6-3 Jump Command

- **GOTO statement**

A GOTO statement, also called an "unconditional jump", causes program execution to continue at designated location (line number) unconditionally.

Format: GOTO { numerical expression ..... line number (1 through 9999)
numerical expression ..... program area number (0 through 9)

When a numerical expression is written immediately following the GOTO statement, program execution jumps to a line number. When a "#" is written immediately following the GOTO statement, program execution jumps to a program area.
The numerical expression may be a numerical value, a variable or a calculation formula.

Example:

GOTO 10 ..... jump to line 10

GOTO N ..... jump to the line number which is the value of variable N (jump to line 30 if N is 30)

GOTO A*100 ····· jump to the line number which is the result of A*100 (jump to line 200 if A is 2)

GOTO #2 ····· jump to the P2 program area

GOTO #X ····· jump to the program area which is the value of variable X (jump to the P8 program area if X is 8)

GOTO #P+1 ····· jump to the program area which is the result of P+1 (jump to the P5 program area if P is 4)

A GOTO statement is used to repeat program execution from the beginning or to jump to another program to perform a particular calculation.

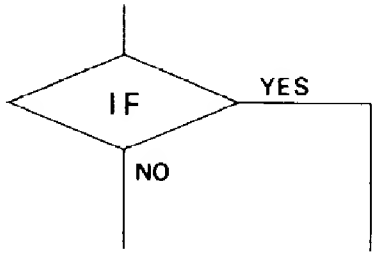
5-6-4 Judgement Command

- **IF statement**

An IF statement is also called a "conditional jump". This command is used to perform some operation or to jump to a designated location only when a certain condition is satisfied.

Format: IF comparison expression { THEN line number or #*n* (*n* = 0 through 9) / ; command or substitution statement }

The comparison expression following the "IF" compares the right side and the left side of "=" (equal to) or "≠" (not equal to) signs, and if the condition is satisfied, program execution proceeds to the specified location. If the condition is not satisfied, execution proceeds to the next line.
This operation is shown in the flowchart below.



As the flowchart shows, if the IF statement condition is fulfilled, the process goes in the "YES" direction, but if the IF statement is not fulfilled, the process continues in the "NO" direction.
In other words, an IF statement indicates a branch and selects the next operation as a direct result of judgement. An IF statement can be used to terminate a loop (repetition) when the number of data is unknown or to select the next operation based on a calculation result, etc.
Constants/variables/numerical expressions/character constants/character variables can be used for this comparison.

A>10	variable and constant (if A is greater than 10 → YES)
X≥Y	variable and variable (if X is equal to or greater than Y → YES)
N=L+3	variable and numerical expression (if N is equal to the sum of L and 3 → YES)
A$="XYZ"	character variable and character constant (if the character string contained in A$ is equal to "XYZ" → YES)
P$=Q$	character variable and character variable (if the character string in P$ and the character string in Q$ are equal → YES)

* Comparison of variables and character variables cannot be made.
* Character string comparison is based on the ASCII.

"THEN" or ";" (semicolon) are used separately depending upon what follows.

THEN 150	(line number)
THEN #9	(program area)
:PRINT A	
:Z=X+Y	

5-6-5 Loop Command

- **FOR·NEXT statement**

A FOR·NEXT statement is used when you want to perform similar operations repeatedly and the number of repetitions (loops) is known.

Format: FOR variable = $\underset{\text{initial value}}{n}$ TO $\underset{\text{final value}}{m}$ $\left[\text{STEP } \underset{\text{increment}}{\ell}\right]$

NEXT variable

(Item enclosed in brackets may be omitted.)
(n, m and ℓ are numerical expressions.)

In other words, this is a command to repeatedly execute the command between "FOR" and "NEXT" while a variable changes from n to m in increments of ℓ.
When execution reaches m, it proceeds to the command following "NEXT".

Example:

To increase variable I in increments of 2 between 1 and 10.

```
FOR I=1  TO 10 STEP 2
    ⟩
NEXT I
```

To reduce variable A in increments of 0.5 between 50 and 1.

```
FOR A=50 TO 1 STEP-0.5
    ⟩
NEXT A
```

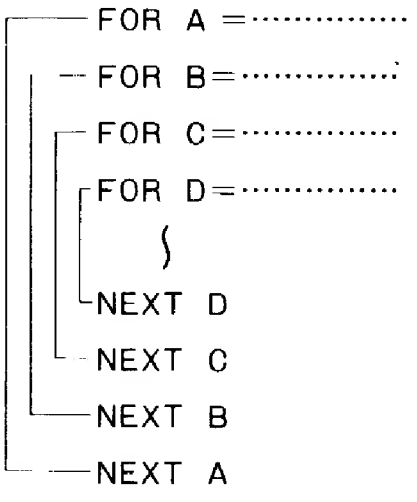
To increase variable P in increments of 1 between Q and R.

```
FOR P=Q TO R
    ⟩
NEXT P
```

* When increase is performed in increments of 1, "STEP" may be omitted.

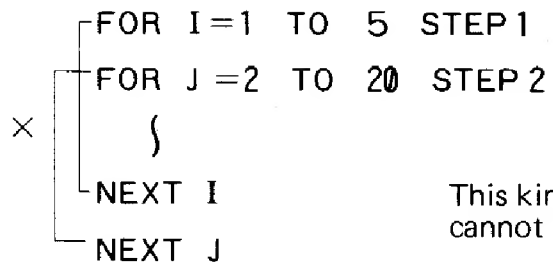
*** Nesting**

Up to 4 FOR•NEXT loops can be stacked. This stacking is called "nesting".



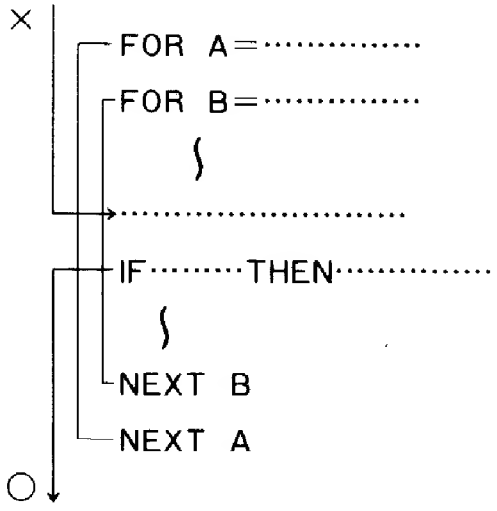
This shows 4-stack nesting.

When nesting is performed in this manner, attention must be paid to the NEXT statement and its variable which correspond to the FOR statement.



This kind of FOR•NEXT loop cannot be assembled.

Furthermore, exit from FOR•NEXT loop is permitted but entry to FOR•NEXT loop is not permitted.



5-6-6 Subroutine Command

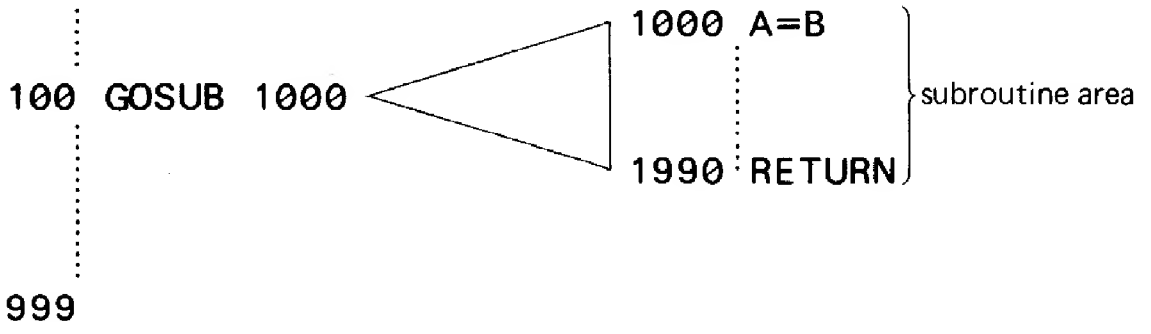
- **GOSUB statement**

A subroutine is also called a "subprogram". Subroutines are separate programs to be called out from a main routine.
The command to call out a subroutine is a GOSUB statement. Using this command, program execution jumps from the main routine to the subroutine. After the subroutine is executed, the program returns to the original location in the main program (using the RETURN statement in the subroutine).

Format: GOSUB { numerical expression / # numerical expression ..... subroutine callout (jump) command
RETURN ..... command to return to main routine

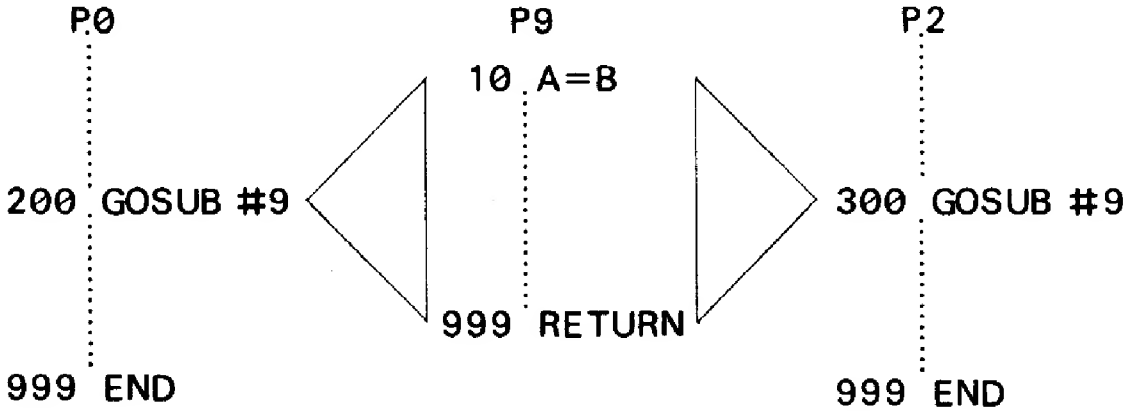
The numerical expression following the GOSUB statement indicates the initial line number of the subroutine area. Without a RETURN statement at the end of the subroutine area, program execution cannot return to the main routine.

Example:



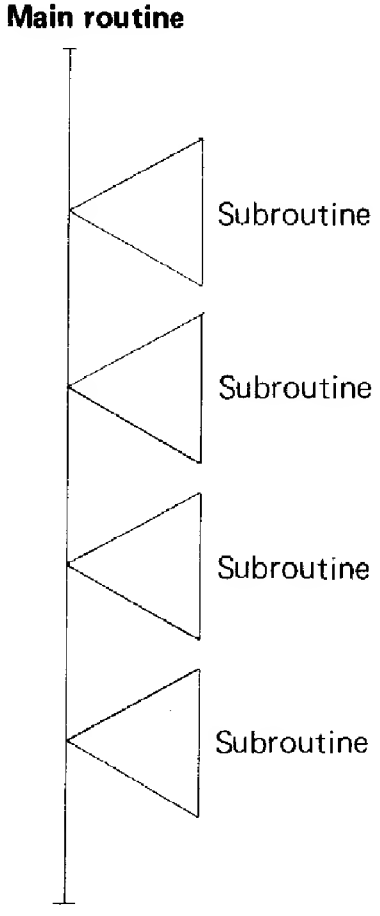
The numerical expression following a GOSUB statement may be either a numerical variable or a calculation formula. In the case of a variable or a numerical expression, the subroutine which is called out will be different depending on the numerical value contained in the variable or the result of the numerical expression. When a "#" is attached prior to the numerical expression, another program area (P0 through P9) will be used as the subroutine. This method is very convenient because even different programs can use the same subroutine.

Example:

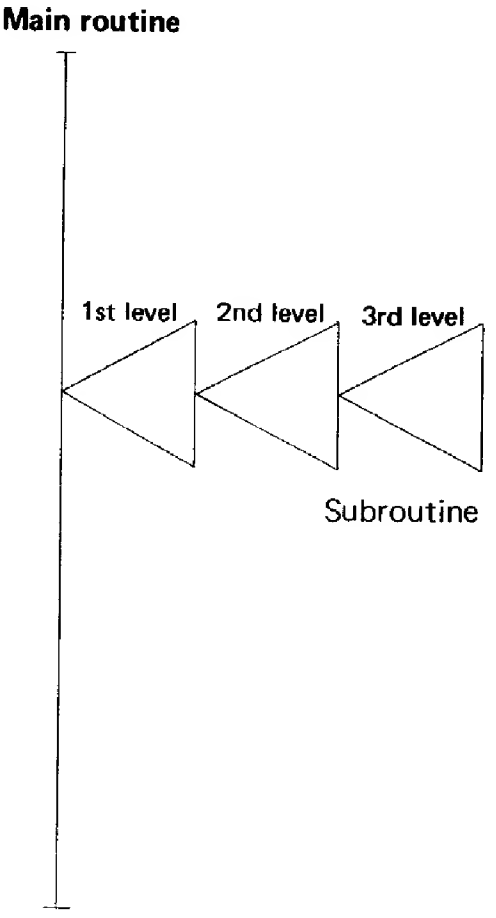


- **Nesting**

Similar to the FOR•NEXT statement, GOSUB statements can also be stacked. The number of times the subroutine is called out is fixed.
This nesting can be performed up to 8 levels. Consequently, a subroutine can be called out from a subroutine.



In this example, the subroutines are not stacked so you can use as many as you like.



This example shows three levels of nesting. Up to 8 levels can be stacked.

A subroutine is convenient for assembling common portions of a main routine in order to save the number of steps or for assembling portions separately as subroutines when assembling a complicated program.

5-6-7 Multistatement

A multistatement is used to connect two or more commands using a ":" (colon).

Example:

```
10 A=2
20 B=10
30 C=50
```

```
10 A=2:B=10:C=50
```

```
10 PRINT "NO." ;N;
20 INPUT A
```

```
10 PRINT "NO." ;N;: INPUT A
```

5-6-8 Stop Command

- **STOP statement**

A STOP statement is a command to stop program execution temporarily. When a program is stopped using this command, press the EXE Key to resume program execution.

Any number of STOP commands can be written in a program.

5-6-9 End Command

- **END statement**

An END statement is a command to terminate program execution. Program execution cannot be resumed as it can with a STOP statement.

END statement is written at the end of a program. When a subroutine follows the main program, be sure to write an END statement at the end of the main routine.

5-6-10 Execute Command

- **RUN command**

A RUN command is used to execute a program. It cannot be used by writing it in a program.

Format: RUN [line number] (Item in brackets may be omitted)

When followed by a line number, the program will start from that line number. If it is omitted, the program will start from the initial line.

Example:

RUN EXE ····· start from the beginning

RUN 20 EXE ····· start from line 20

RUN 55 EXE ····· start from line 55

When the designated line number does not exist, execution will start from the line with the next nearest line number.

5-6-11 List Command

- **LIST command**

A LIST command is used to display the program contents. It can be used in both the "RUN" mode and the "WRT" mode.

Format: LIST [line number] (Item in brackets may be omitted)
LIST A

When followed by a line number, the program will be displayed in sequence starting from the designated line number of the currently designated program area. When no line number is designated, display will be made from the beginning of the program.
In the case of "LIST A", this is a command to display the programs in all program areas. It displays program contents sequentially from P0 through P9. This command cannot be used by writing it in a program.
When performed in the "RUN" mode, the program contents will be displayed sequentially from the designated line. However, when performed in the "WRT" mode, one line is displayed each time the EXE Key is pressed.

Example:

(RUN mode)

```
LIST EXE
10 A=0
20 INPUT B
30 A=A+B
40 GOTO 20
```

(WRT mode)

```
.LIST 20 EXE
20 INPUT B_
EXE
30 A=A+B_
EXE
40 GOTO 20_
```

Also, if performed in the "WRT" mode, program editing (refer to page 34) is possible.

5-6-12 Mode Designation

- **MODE command**

The MODE command is used to designate the angular unit or printer output condition in a program.

Format: MODE n (n = 4 through 8)

MODE 4 "**DEG**" designation
MODE 5 "**RAD**" designation } angular unit designation
MODE 6 "**GRA**" designation
MODE 7 PRINT mode designation
MODE 8 PRINT mode release

This MODE command is the same as the designation which is performed by pressing the MODE Key during manual operation.

5-6-13 Output Format

- **SET command**

A SET command is used to designate the display output format. It designates the number of effective positions and the number of decimal positions.

Format: SET E n ····· designation of number of effective positions (n = 0 through 8)
SET F n ····· designation of number of decimal positions (n = 0 through 9)
SET N ····· designation release

* If SET E 0 is used when designating the number of effective positions, 8 positions will be designated. This command can be performed manually or by writing it in a program. Refer to page 25 for display contents.

5-6-14 Character Functions

- **LEN**

The LEN function is used to count the number of characters in a character variable. It permits the size of the character variable to be known.

Format: LEN (character variable)

Example:

If A$= "ABCDE" LEN(A$)=5.

- **MID**

The MID function is only used with the exclusive character variable ($). It extracts a certain number of characters from the character string in the $ variable.

Format: MID (m [, n]) m and n are numerical expressions and must be between 1 and 30.
(Items in [ ] may be omitted.)

This means to extract n characters from the mth character of the character string stored in the exclusive character variable ($).
Numerical expression m should not exceed the number of characters stored. Also, $m+n$ should not exceed the number of stored characters + 1.
Furthermore, when numerical expression n is omitted, all of the characters from m on will be extracted.

Example:

If $= "PC-4"
MID (2,3) = "C-4" and MID (4) = "4"

- **VAL**

The VAL function changes the numbers in a character variable into a numerical value.

Format: VAL (character variable)

Since this function changes the numbers in the character variable into a numerical value, when there are no numbers in the character variable (for example, "ABC"), an error will occur.

Example: If Z$= "78963", VAL (Z$) =78963

Note: When this function is used in a program and an error occurs as a result of lacking numbers in the data, "ERR 2" will be displayed but not the program area and line number.

5-6-15 Memory Clear

- **VAC**

The VAC command clears the data in all variables. It makes numerical variables "Ø" and makes character variables "null".
This command can be used by writing it in a program or manually. Therefore, when you want to clear all data prior to executing a program, input VAC at the beginning of the program.

Example: Writing in the program

```
10  VAC
    :
    :
```

Manual execution

VAC EXE

5-6-16 Program Clear

- **Clear command**

A CLEAR command is used to clear a program which has been written. It is executed manually in the "WRT" mode.

Format: CLEAR

CLEAR A

A "CLEAR" command only clears the program in the currently designated program area (PØ, P1, etc.) A "CLEAR A" command clears all programs in all program areas from PØ through P9.

Example:

[MODE][1] CLEAR [EXE] ·····clears a single program

[MODE][1] CLEAR A [EXE] ·····clears all programs in all areas.

5-6-17 Option Specifications

■ Cassette Magnetic Tape

In order to record programs or data stored in this unit on a cassette tape with the PC-4, use the PC-4 cassette interface and an ordinary tape recorder. If the tape recorder has a remote terminal, remote control can be conveniently controlled from the PC-4 through the Cassette Interface.
For tape recorder connection procedures and detailed operating procedures, refer to the PC-4 Cassette Interface operation manual.

- **Program recording**

Format: SAVE ["filename"] (Item in brackets may be omitted.)

The filename may be composed of alphabetical letters, numbers, symbols, enclosed in quotation marks and contain up to 8 characters.

Example:

"ABC"

"NO.1"

This command starts the tape recorder in the RECORD position.

Operation: SAVE ["filename"] [EXE]

A SAVE command can only be used manually.

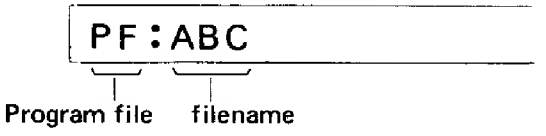
- **Program callout**

Format: LOAD ["filename"] (Item in brackets may be omitted.)

This command starts the tape recorder in the PLAYBACK position.

Operation: LOAD ["filename"] [EXE]

Display during program load



A program that has been written in a designated area will be erased starting with the initial line number of the program to be loaded if a call out is performed.

- **Recording All Programs**

Format: SAVE A ["filename"] (Item in brackets may be omitted.)

This command simultaneously records all the programs which are written in all program areas from P0 through P9.
The operation method is similar to the SAVE command and the tape recorder is started in the RECORD position.

Operation:

SAVE A ["filename"] EXE

- **Callout of all programs**

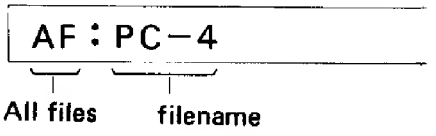
Format: LOAD A ["filename"] (Item in brackets may be omitted.)

This command simultaneously calls out all the programs from all the program areas which were previously recorded using the SAVE A command. The operation is similar to the LOAD command and the tape recorder is started in the PLAYBACK position.

Operation:

LOAD A ["filename"] EXE

Display during program load



Programs that are already written in program areas prior to callout will be cleared and the new programs will replace them.
The SAVE A command and the LOAD A command can be used manually.

- **Data recording**

Format: PUT ["filename"] variable 1 [, variable 2]
(Items in brackets may be omitted.)

The data which is recorded on the tape is the data in the variables from variable 1 through variable 2.

Example: PUT "PB" A ·····data of variable A

PUT "1−2" A,Z ·····data of variables A through Z

PUT "DT" $,A,Z(10)····· data of character variable $ and variables A through Z(10)

When recording the data in the exclusive character variable $, write $ first.
This command can be used either manually or by writing it in a program.
For manual operation, start the tape recorder in the RECORD position.

Operation:

PUT ["filename"] variable 1 [, variable 2] EXE

When using the PUT command in a program, write it along with the line number and start the written program.

- **Data callout**

Format: GET ["filename"] variable 1 [, variable 2]
(Items in brackets may be omitted.)

This command can be used either manually or by writing it in a program.
For manual use, start the tape recorder in the PLAYBACK position and operate as follows.

GET ["filename"] variable 1 [, variable 2] EXE

For use in a program, write it in along a line number attached and start the program.

- **Checking the file which has been recorded on the tape**

A VER command is used to check whether the programs or data have been recorded properly.

Format: VER ["filename"] (Item in brackets may be omitted.)

The operation sequence is similar to program load.

■ Printer

An exclusive mini printer can be connected to the PC-4. By connecting this printer, program lists, data and even calculation results during execution can be printed out. For printer connection and operating procedures, refer to the Mini Printer Operation Manual.

To print a program list, press MODE 7 and designate the PRT mode.

Program list

MODE 2 MODE 7
LIST EXE or LIST A EXE
MODE 8 (PRT mode release)

After printout is complete, be sure to press MODE 8 and release the PRT mode.
Also, to print calculation results or operation contents, printout can be performed automatically by writing "MODE 7" and "MODE 8" in the program.

Example:

```
100 MODE 7
110 PRINT A
120 MODE 8
```

When "MODE 7" is written in the program, be sure to write "MODE 8" prior to program termination and release the PRT mode.

Error Message List

Error code	Meaning	Cause	Corrective measure
1	Memory overflow or system stack overflow	• Program cannot be written due to insufficient number of steps or memory cannot be expanded. • Stack overflow due to a complicated calculation formula.	• Clear unnecessary programs or reduce the number of memories. • Divide and simplify the numerical expression.
2	Syntax error	• A mistake has been made in writing the program, etc. • The left side format is different from the right side format in a substitution statement, etc.	• Correct the error in the input program, etc.
3	Mathematical error	• The calculation result of a numerical expression is 10^{100} or greater. • Outside the input range of a numerical function. • The result is indefinite or impossible.	• Correct the calculation formula or data. • Verify the data.
4	Undefined line number error	• No designated line number for a GOTO statement or a GOSUB statement	• Correct the designated line number.
5	Argument error	• For a command or function that requires an argument, the argument is outside the input range.	• Correct the argument error.
6	Variable error	• Attempt was made to use a memory which has not been expanded. • Attempt was made to use the same memory for a numerical variable and a character variable at the same time.	• Expand the memory properly. • Do not use the same memory for a numerical variable and a character variable at the same time.
7	Nesting error	• A RETURN statement appears other than during subroutine execution. • A NEXT statement appears other than during a FOR loop or the variable of the NEXT statement is different from that of the FOR statement. • Subroutine nesting exceeds 8 levels. • FOR loop nesting exceeds 4 levels.	• Remove the unnecessary RETURN statement or NEXT statement. • Reduce the subroutines or FOR•NEXT loops to within the maximum levels.
9	Option error	• Execution is performed in the PRT mode or option command such as SAVE is executed when no printer or tape recorder is connected.	• Connect a printer or tape recorder. • Release the PRT mode.

Program Command List

Classification	Command name	Format	Function
Input statement	INPUT	INPUT variable string	Causes data to be entered from the keyboard during execution of a program. The program execution is stopped until after the end of input. **P.44**
	KEY	Character variable = KEY	Reads a character entered during execution of a program and assigns it to a character variable. Since the program is not stopped by this command, nothing is assigned to the character variable if no key entry is made. **P.45**
Output statement	PRINT	PRINT output control function {;/,} output element {{;/,} ....}	Outputs the designated output element. **P.45**
	CSR	CSR n {;/,} $(0 \leqq n \leqq 11)$	Displays from the designated nth position. **P.46**
Branching	GOTO	GOTO {line number/variable}	Causes control to jump to the designated line number. **P.47**
	IF	IF comparison expression {THEN/;} .. {THEN line number/; command}	Causes control to jump to the line number following THEN, or executes the command following ";", if the result of the comparison is true. Causes control to proceed to the next line number if the result of the comparison is false. **P.48**
	GOSUB	GOSUB {line number/variable}	Calls out the subroutine of the designated line number for execution. After the subroutine is executed, control returns to the GOSUB statement by the RETURN statement to proceed to the command following that statement. **P.51**
	RETURN	RETURN	Signifies the end of a subroutine; returns control to a command/function next to the GOSUB statement. **P.51**
Looping	FOR	FOR $v=e_1$ TO e_2 [STEP e_3] * v denotes a numerical variable, and e_1, e_2 and e_3 represent a numerical expression respectively.	Declares the beginning of a loop in which numerical value v changes from initial value e_1 to terminal value e_2 in increments of e_3. The loop is repeated "$\left[\frac{e_2-e_1}{e_3}\right]+1$" times between the FOR and NEXT statements. If the increment e_3 is omitted, e_3 is regarded as "1". **P.49**

Classification	Command name	Format	Function
Looping	NEXT	NEXT v	Signifies the end of a FOR loop. If the result of v plus e_3 is equal to or smaller than e_2, the loop is repeated again. If it is greater than e_2, control proceeds to the line next to the NEXT statement. **P.49**
Execution stop	STOP	STOP	Stops the execution of a program temporarily to bring the system into a key-in wait state. The execution can be continued by pressing the EXE Key. **P.54**
Execution end	END	END	Signifies the end of a program, the system returning to its pre-execution state. The execution of a program, once ended, cannot be continued even if the EXE Key is pressed. **P.54**
Data clearing	VAC	VAC	Clears all variable data for a program. **P.57**
Program listing	LIST	LIST [line number]	Displays a listing of all the statements in a program from the designated line number downward. **P.55**
All program listing	LIST A	LIST A	Displays a listing of the statements in all programs. **P.55**
Program execution	RUN	RUN [line number]	Causes a program to start from the designated line number. **P.54**
Program erasing	CLEAR	CLEAR	Clears the currently designated program area of a program. **P.57**
	CLEAR A	CLEAR A	Clears all the programs. **P.57**
Angular unit designation	MODE	MODE $\begin{Bmatrix} 4 \\ 5 \\ 6 \end{Bmatrix}$	Designates trigonometric angular units as degree (4), radian (5) or gradient (6). **P.55**
Format designation	SET	SET $\begin{cases} En & (0 \leqq n \leqq 8) \\ Fn & (0 \leqq n \leqq 9) \\ N \end{cases}$	Designates the number of effective positions or number of decimal positions for the displayed numerical value. **P.56**
Character function	LEN	LEN (character variable)	Calculates the size of the character variable. **P.56**
	MID	MID (m[, n])	Extracts n characters from the mth character in the exclusive character variable ($). **P.56**
	VAL	VAL (character variable)	Converts the numbers in a character variable to a numerical value. **P.57**

Classification	Command name	Format	Function
Option use	SAVE	SAVE ["filename"]	Records only the program in the currently designated program area on tape. **P.58**
	LOAD	LOAD ["filename"]	Calls out the program from the tape and loads it to the currently designated program area. **P.58**
	SAVE A	SAVE A ["filename"]	Records the programs in all program areas on tape at the same time. **P.59**
	LOAD A	LOAD A ["filename"]	Calls out all programs from the tape and loads them to the respective program areas. **P.59**
	PUT	PUT ["filename"] variable	Records the data in the variable on tape. **P.59**
	GET	GET ["filename"] variable	Calls out the data from the tape and loads it in the variable. **P.60**
	VER	VER ["filename"]	Checks to confirm that the programs or data have been recorded on the tape properly. **P.60**

* Items enclosed in [ ] may be omitted.
Either one of the items enclosed in { } may be used.

Function Digit Capacity	Input range	Result accuracy
$\sin x$, $\cos x$, $\tan x$	$\lvert x\rvert < 1440^\circ$ (8π rad, 1600 gra)	10th digit ± 1
$\sin^{-1} x$, $\cos^{-1} x$	$\lvert x\rvert \leq 1$	"
$\tan^{-1} x$		"
$\log x$, $\ln x$	$x > 0$	"
e^x	$-227 \leq x \leq 230$	"
$\sqrt{x}$	$x \geq 0$	"
x^y (x ↑ y)	When $x < 0$, y is a natural number.	"

Specifications

■ Type
PC-4.

■ Fundamental calculation functions
Negative numbers, exponentials, parenthetical addition, subtraction, multiplication and division (with priority sequence judgement function (true algebraic logic))

■ Built-in function
Trigonometric/inverse trigonometric functions (angular units — degree/radian/gradient), logarithmic/exponential functions, square root, powers, conversion to integer, deletion of integer portion, absolute value, symbolization, designation of number of effective positions, designation of number of decimal positions, random numbers, π

■ Commands
INPUT, PRINT, GOTO, FOR•NEXT, IF-THEN, GOSUB, RETURN, STOP, END, RUN, LIST, LIST A, MODE, SET, VAC, CLEAR, CLEAR A, DEFM, SAVE, SAVE A, LOAD, LOAD A, PUT, GET, VER

■ Program functions
KEY, CSR, LEN, MID, VAL

■ Calculation range
$\pm 1 \times 10^{-99}$ to $\pm 9.999999999 \times 10^{99}$ and 0 (internal calculation uses 12 mantissa positions)

■ Program system
Stored system

■ Program language
BASIC

■ Number of steps
Maximum 544 steps (maximum 1,568 steps when optional RAM pack is loaded)

■ Program capacity
Maximum 10 programs (P0 through P9)

■ Number of memories
Standard 26, expandable to 94 (maximum 222 memories when optional RAM pack is loaded) and exclusive character variable ($)

■ Number of stacks
Subroutine — 8 levels
FOR•NEXT loop — 4 levels
Numerical value — 6 levels
Calculation elements — 12 levels

■ Display system and contents
10 mantissa positions (including minus sign) or 8 mantissa positions (7 positions for negative number) and 2 exponential positions. Also, display of respective conditions such as EXT, [S], RUN, WRT, DEG, RAD, GRA, TR, PRT, STOP

■Display elements
12-position dot matrix display (liquid crystal)

■Main components
C-MOS VLSI and others

■Power supply
2 lithium batteries (CR2032 Cat. No. 23-162)

■Power consumption
Maximum 0.02 W

■Battery life
Mainframe only — approximately 360 hours (Continuous use)

■Auto power-off
Power is turned off automatically approximately 7 minutes after last operation.

■Ambient temperature range
0°C to 40°C (32°F to 104°F)

■Dimensions
9.8H x 165W x 71mmD (3/8"H x 6-1/2"W x 2-3/4"D)

■Weight
116 g (4.1 oz) including batteries

GUIDELINES LAID DOWN BY FCC RULES FOR USE OF THE UNIT IN THE U.S.A. (not applicable to other areas).

This equipment generates and uses radio frequency energy and if not installed and used properly, that is, in strict accordance with the manufacturer's instructions, may cause interference to radio and television reception. It has been type tested and found to comply with the limits for a Class B computing device in accordance with the specifications in Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference in a residential installation. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

... reorient the receiving antenna
... relocate the computer with respect to the receiver
... move the computer away from the receiver
... plug the computer into a different outlet so that computer and receiver are on different branch circuits.

If necessary, the user should consult the dealer or an experienced radio/television technician for additional suggestions. The user may find the following booklet prepared by the Federal Communications Commission helpful: "How to Identify and Resolve Radio-TV Interference Problems". This booklet is available from the US Government Printing Office, Washington, D.C., 20402, Stock No. 004-000-00345-4.

SERVICE POLICY

Radio Shack's nationwide network of service facilities provides quick, convenient, and reliable repair services for all of its computer products, in most instances. Warranty service will be performed in accordance with Radio Shack's Limited Warranty. Non-warranty service will be provided at reasonable parts and labor costs.

Because of the sensitivity of computer equipment, and the problems which can result from improper servicing, the following limitations also apply to the services offered by Radio Shack:

1. If any of the warranty seals on any Radio Shack computer products are broken, Radio Shack reserves the right to refuse to service the equipment or to void any remaining warranty on the equipment.
2. If any Radio Shack computer equipment has been modified so that it is not within manufacturer's specifications, including, but not limited to, the installation of any non-Radio Shack parts, components, or replacement boards, then Radio Shack reserves the right to refuse to service the equipment, void any remaining warranty, remove and replace any non-Radio Shack part found in the equipment, and perform whatever modifications are necessary to return the equipment to original factory manufacturer's specifications.
3. The cost for the labor and parts required to return the Radio Shack computer equipment to original manufacturer's specifications will be charged to the customer in addition to the normal repair charge.

RADIO SHACK, A DIVISION OF TANDY CORPORATION

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CANADA: BARRIE, ONTARIO,L4M 4W5

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㊞ Printed in Japan